Attention Biology & Environmental Science Teachers!

FLEXE is currently seeking students (grades 7-12) to participate in this year's pilot program.

2010 FLEXE Extreme Ecology Unit Pilot

GLOBE students in Biology, Life Science, or Environmental Science classes are invited to participate in the new FLEXE Extreme Ecology Pilot, to begin January 2010. Participating students will investigate key concepts of deep-sea ecology, apply these concepts to the study of their environment and interact with deep-sea scientists through the FLEXE Forum. Students will:

- Learn key ecological concepts and investigate biotic/abiotic interactions within an ecosystem,
- Explore remote research techniques and analyze datasets that help to characterize ecosystems (e.g., photomosaics from the deep ocean, sampling communities),
- Draw comparisons between local and deep-sea ecosystems through the exploration of concepts such as chemosynthesis, feeding adaptations, community trophic structure, symbiosis, community succession, and biodiversity,
- Interact with deep-sea scientists through the Web-based FLEXE Forum to deepen and apply their understanding of ecological processes to other parts of the Earth system - the extreme environments of hydrothermal vents and cold seeps,
- Synthesize unit concepts and propose ecological research investigations in their own environment (optional).

FLEXE Extreme Ecology Unit Student Learning Outcomes:

FLEXE students develop their understanding of key Earth systems concepts, gain experience and skills in scientific inquiry and critical thinking, and deepen their understanding of the process and nature of science. Essential questions include:

- How does energy transfer between organisms in an ecosystem?
- What forces and factors shape ecosystem processes such as community succession?
- How is my local environment similar to and different from an 'extreme' environment?
- How might organisms and ecosystems respond to climate change in local and 'extreme' environments?

FLEXE Pilot Timeline:

The FLEXE pilot consists of a sequence of classroom activities and on-line activities that involve Web-based interactions with scientists through the FLEXE Forum. Activities requiring interaction with scientists will be ***scheduled*** to occur at a particular time (see ***bolded activities below***). Other activities may be completed at your own pace although the order of activities should be maintained.

The following sequence includes minimum estimated class periods required:

1. *Introduction to Ecology & Your Local Site Survey* (2-3 class periods in January)
2. ***FLEXE Forum – How ecologists study the deep seafloor*** **(3 class periods in January)**
3. *The Tubeworm Mystery* (1-2 class periods in February)
4. *Mussel Lab – "How big are your mussels?"* (2 class periods in February)
5. ***FLEXE Forum – Adaptations & Symbiosis*** **(3 class periods in February)**
6. *Food Webs and Community Succession* (3 class periods in March)
7. ***FLEXE Forum – Deep-Sea Biodiversity*** **(3 class periods in March)**

8. *Change and Your Local Environment* (1 class period in April) *optional*
Estimated class periods required: 18-20

Language Requirement:
Participating students must be able to read and write Forum responses in English.

Teacher Training:
To introduce the deep-sea extreme environment and familiarize teachers with the FLEXE learning activities and on-line system, the FLEXE team will provide teacher training, either in-person or online. Training will include an introduction to the extreme environment by a FLEXE scientist along with an overview of activities and on-line system components including the FLEXE Forum and TeacherTools. For international participants, the FLEXE Team will work with GLOBE country coordinators to arrange dates for training to meet the needs of teachers in key regions. Trainings will be offered in December 2009 and early January 2010.

Pilot Evaluation:
Evaluation is crucial to the project. Participating teachers will provide feedback on lessons at the end of the pilot. Student comprehension and attitudes towards science will be assessed through anonymous short questionnaires administered on-line at the end of each activity. Effects of interactions with scientists will be assessed through analysis of students' written responses to Forum activities. Classes will be randomly assigned to one of two groups indicating the level of interaction with Forum scientists. Students in the first group will receive scientist feedback that includes reference to student responses. Students in the control group will receive scientist feedback that does not include reference to student responses.

Student anonymity will be maintained throughout the pilot – user IDs and passwords will be provided and will be assigned by the teacher. PSU Institutional Review Board (IRB) research protocol will be followed including obtaining school administrator and teacher consent prior to participation in pilot.

Commitment and Equipment Required:
Classes taking part in the pilot are expected to participate in all required activities of the FLEXE Extreme Ecology Unit, which are anticipated to take approximately 20 class periods (~45 minutes) of classroom time over a 4-month period. Three of these activities **require** use of a computer lab. Students will work in pairs, and for on-line portions of activities will need a networked computer for each pair of students. NOTE: The unit is designed to lead students to develop ideas for their own research investigations, although time spent on student investigations is additional and considered optional.

Teachers should plan on some modest out-of-class time for preparation and evaluation. During the pilot, online and telephone support will be available for teachers with questions or problems.

Bonuses for Taking Part:
Classes who take part in all pilot activities will receive a variety of resources, including: a classroom poster of the deep-sea environment, a resource book such as *Deep-Ocean Journeys* by Dr. C.L. Van Dover or a DVD such as *Aliens of the Deep*, and “surprises from the deep” (these may include shells of deep-sea animals, or new volcanic rock from seafloor spreading centers). As a special bonus, participating classes are invited to send in one personalized, decorated Styrofoam cup to be taken to sea during a research cruise. The cups will be taken to the seafloor and then returned to the classroom after the cruise.

FLEXE Extreme Ecology Learning Activities and Forums

Scientific Observation in our Local Study Site

In this activity, students identify a study site in their local environment (school yard, etc.) and follow a modified GLOBE protocol to document the abiotic and biotic components of the site, including relationships (connections) between the two. Key concepts include:

- An ecosystem is characterized by living (biotic) and non-living (abiotic) components that influence one another
- Changes in the environment can impact the biotic and abiotic components of an ecosystem
- Scientists use protocols and techniques to characterize and document a study site

FLEXE Forum – How Ecologists Study the Deep Seafloor

FLEXE Forums involve unique, Web-based interactions with scientists who study deep-sea environments. In this Forum, Dr. Chuck Fisher from Penn State University will post a dataset featuring the distribution patterns of organisms around hydrothermal vents along with probing questions to guide student analysis. Students interpret the data and post their responses on-line, and then Dr. Fisher provides feedback to students via the Forum. Key concepts include:

- Remote environments such as the deep-sea present unique challenges to research
- The distribution of organisms is influenced by many factors, both biotic and abiotic

The Tubeworm Mystery: how microbes harness chemical energy to fuel the tubeworm community.

In this activity, students are introduced to the keystone role of bacterial chemosynthesis in deep-sea hydrothermal vent and cold seep communities. Students explore the historical perspective of the discovery of vents and learn about chemosynthesis and how microbes are able to harness energy from the vent and seep fluids. Students will contrast photosynthesis with chemosynthesis and compare the role of the respective processes in local vs. deep-sea environments. Key concepts include:

- Chemosynthesis is a process by which microbes convert inorganic carbon to organic carbon through the use of chemical energy
- Microorganisms form the basis of the deep-sea foodweb

Mussel Lab: How Big Are Your Mussels?

In this 2-part activity, students investigate how another deep-sea foundation species – mussels – obtains nutrition, and explore the concept of symbiosis. In Part 1, students follow a FLEXE protocol to obtain morphological data from locally obtained mussels and create a class dataset. In Part 2, students compare their data to data from deep-sea mussels obtained using the same protocol. Key concepts include:

- Symbiosis describes the interaction in which dissimilar organisms live together in close association
- Organisms adapt over time to abiotic and biotic conditions in their environment

FLEXE Forum – Adaptations & Symbiosis

In this FLEXE Forum, Dr. Nicole Dubilier from the Max Planck Institute in Germany will follow up on the Mussel lab and discuss with students the importance of symbiosis in deep-sea ecosystems. Students will use results from the Mussel Lab and the Tubeworm activity to answer Forum questions regarding differences in feeding strategies of related species. Students will be introduced to techniques used to study deep-sea species and their symbionts, and will be introduced to recent findings comparing species from different locations. Key concepts include:

- Adaptations can increase the survival and/or reproductive success (fitness) of organisms, and/or allow organisms to colonize other habitats

Food Webs and Community Dynamics

In this 3-part activity, students explore the transfer of energy between organisms through the exploration and comparison of food webs and trophic levels in local, hydrothermal vent, and cold seep ecosystems. Students construct food webs using on-line interactive tools and organism cards, and examine changes in community trophic structure as a result of succession. Key concepts include:

- Deep sea communities rely on chemosynthesis as a source of primary production
- Organisms play different (trophic) roles in the transfer of energy in an ecosystem
- Ecosystems are dynamic communities of organisms that change over time in response to changes in environmental conditions and the activities and interactions of different species

FLEXE Forum – Deep-Sea Biodiversity

In this FLEXE Forum, Dr. Erik Cordes of Temple University will introduce students to methods to quantitatively characterize the biological community of a hydrothermal vent or cold seep study site, including the concepts of species richness, species abundance, evenness, diversity indices, and rarefaction techniques. Key concepts include:

- Biological communities can differ in the relative abundance and diversity of organisms
- Deep-sea communities are characterized by high biomass and low diversity compared with the open seafloor.

Change and Your Local Environment (optional)

In this optional activity, students apply their new knowledge of ecological concepts to explore questions they have about their study site and in particular, how environmental change may affect their local environment. Students learn how to turn questions into testable research questions that can form the basis of investigations they may wish to pursue. Key concepts include:

- "Overarching questions" may be addressed by smaller, "testable research questions"

If you would like to participate in this FLEXE project, please complete the attached form by October 15, 2009. We look forward to working with you.

***** FLEXE Extreme Ecology Unit Pilot *****
January – April, 2010

Please complete the form and return (email or mail) to the FLEXE Project Office. Forms due by October 15, 2009

Teacher Name:

Email:

Phone contact(s):

School Name:

School Address: (Street address, City, State or Province, Postal Code, Country)

Class Description(s): (for each class to participate, please provide course name, grade level and number of students)

Please describe why you are interested in participating in FLEXE.

Please complete the form and email to: flexe@psu.edu

Or mail the form to:

FLEXE Project Office (attn: Liz Goehring)
Pennsylvania State University
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USA